COVER SHEET

Natascha Matthes • Marcus Foth

Designing engaging interactions for exploration and sharing of multidisciplinary outcomes in Environmental Education

Ubicomp for human horticulture rather than social engineering

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Abstract The recent advent of mash-ups based on geo-browsers and social networking technologies holds great potential to use maps for sharing outcomes of activities in Environmental Education and to raise awareness around environmental sustainability issues. However, in this paper we argue that further interaction design research for online community applications in the context of Environmental Education is required in two ways. Firstly, this project is investigating how exploration, contribution and sharing of environmental outcomes can be seamlessly embedded in the existing practice of Environmental Education to engage students in environmental activities. For this purpose, it is investigating various facets of ubiquitous computing, namely web-based interfaces, mobile technology use and tangible media installations. Secondly, this project analyses challenges to the dominant map and planet metaphors as virtual copies of the real world and explores design and metaphor alternatives which integrate outcomes of multi-disciplinary, environmental initiatives that may not necessarily be location-specific. In line with the strong participatory strategy of Environmental Education itself, this practice-led design research uses a participatory design methodology and includes students, educators, organisers, and mentors of environmental activities in an initial user needs analysis, the design process and evaluation of prototypes.

Keywords Environmental Education • online community • social networking • ubiquitous computing • interaction design • mobile technology • tangible media • interfaces

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Natascha Matthes • Marcus Foth
Queensland University of Technology
Tel.: +61-7-313-88137
E-mail: n.matthes@qut.edu.au, m.foth@qut.edu.au

1 Introduction

The roots of the term ‘sustainability’ can be traced back to the universal notion that any resources needed to initiate and continue a process should eventually be replaced or replenished by that same process. The notion of environmentally sustainable development has been introduced to describe initiatives to reduce greenhouse gases or improve water and air quality. It is obvious that in these examples the term ‘sustainable’ is far more complex than the ideal of a mathematical equation or an economic principle (e.g., supply vs. demand). Any discussion of sustainability requires a distinction between activities which aim at achieving a level of sustainability (the means) and the state of being sustainable (the end). The means imply at least four contextual factors, namely

– the range of financial, material and in-kind resources involved;
– the range of stakeholders and interest groups (public / private, commercial / non-profit, individual / communal, local / regional / national / global, etc.);
– the kind of activities; and,
– the time and place.

The end, the state of being sustainable, is theoretically a type of equilibrium that necessitates the contextual factors of the means to enter a stable and balanced interrelationship with one another [1]. Environmental Education plays a key role in education for sustainability. It works across all contextual factors to not only raise awareness but also to enable people to acquire knowledge, skills and values “leading to changed behaviour in support of an ecologically sustainable environment” [2, p5]. Various studies point out that the complexity of sustainability remains a key, yet controversial issue to be investigated both in the realm of Environmental Education as well as supporting disciplines such as, in our case, ubiquitous computing.

This paper contributes to this inquiry into environmental sustainability. Far too often, such inquiries are limited to accountability and financial aspects of sustainability. This paper seeks to expand this narrow view by discussing work-in-progress to better understand effective interaction design to engage a learning community in Environmental Education. This discussion offers us an opportunity to explore some of the ways our work intersects with values and practices linked to environmental sustainability.

2 Contextual review and related works

Many educational, volunteer and event-based initiatives engage participants in activities to raise awareness around environmental issues. In such participatory Environmental Education contexts, the use of maps as a metaphor and menu to share location-specific outcomes of these activities has been widely used and accepted, for example, by community networks [3] as well as by data providers and users of environmental map sharing [4]. The recent advent of geo-browsers, such as Google Earth, has taken this one step further by making the interface metaphor of our 'planet' [5] easily accessible to the public. These applications enable users to contribute to a growing online community around the 'planet' metaphor by annotating it with location-specific information, such as photographs and historical data. Arno Scharl points out that this geospatial technology holds enormous potential for virtual communities and may revolutionize "the production, distribution and consumption of media products" [5, p3]. This is also underlined by the continuously growing number of mash-ups of existing social networks, such as photo-sharing communities and travelblog sites, with geo-browsers. In an environmental context, these annotations of the world may include location-based information such as water-quality data and ant or weed infestations to be shared and collaborated on online.

Access to web-based geospatial applications is not limited to computer browsers. Recent initiatives to engage 'offline' communities in participatory, environmental activities have taken advantage of the latest developments in mobile technology. Two recent examples are Urban Atmospheres' *Participatory Urbanism* project [6] and the *Participate* project [7]. The latter engages students and other members of the public in environmental activities by equipping them with mobile devices that automatically measure and collect environmental data. This collaboratively gathered data is combined into a shared geospatial, online space to visualise environmental situations across the country. Participatory initiatives like these have great potential to engage communities and raise awareness around scientifically environmental foci.

Further research projects informing our study have applied ubiquitous computing in context- and location-aware scenarios with an environmental focus. Even though these projects have not necessarily investigated sharing of outcomes of environmental activities in an online space, they have shown considerable impact on engaging participants through ubiquitous computing in environmental activities. Research foci of these projects include digital augmentation of outdoor settings to support and engage students in fieldtrips (e.g. *Ambient Wood* [8]), digital annotations of physical spaces (e.g. *GeoNotes* [9]), as well as location-based gaming (as conducted, e.g. by Blast Theory [10] and planned with environmental foci for *Participate* [7]).

Design considerations. In the context of sharing outcomes of activities in Environmental Education, a discussion of the limitations when relying solely on geo-spatial representations seems necessary and may also require further consideration for the use of ubiquitous computing.

Environmental activities are not necessarily limited to location-based scientific data collections, but may also include other, diverse activities. On the one hand, we are looking at theme-based rather than location-based artefacts, such as artistic or cultural works. The *River of Words* contest, e.g., engages young people in creating visual and poetry artworks in order to artistically express their appreciation for the environment [11]. The outcomes in response to such environmental activities are often exhibited in location-independent, '2D' online galleries. On the other hand, it is an important aspect of Environmental Education to engage participants in environmental experiences based on physical activities, such as hiking and canoeing. These may not only raise awareness for the environment but may also lead to externalized outcomes in the form of reports or poetry independent of a specific location but rather based on the experience itself.

Taking these two aspects into account, the dominant map and planet metaphor appears to be challenged and not sufficient for sharing more diverse outcomes of Environmental activities. Scharl argues, that all human artefacts are connected to locations [5], e.g. to their creation and usage location as well as to locations that the artefacts reference. Even though this is applicable in Scharl's example of newspaper articles, it is apparent that the visual and contextual integration of interpretative, artistic and non-location specific outcomes of environmental activities may not be as simple as annotating them to related locations on a map. Thus, our study is currently investigating how other metaphors could be used to overcome these issues.

3 The design project

Overview. We aim to create tools and applications to support and engage participants of Environmental Education activities in their work and the way they communicate, collaborate and share their outcomes. The overall research question is: How can interfaces and interactions be designed to engage members of an Environmental Education learning community in exploring, creating, sharing and collaborating on theme-based user-generated content in a virtual online space? To help answer this question, the project follows three interaction design approaches to successfully facilitate integration and use of a collaborative online community application throughout the process of existing Environmental Education activities.

Firstly, we design web-based interfaces to encourage exploration of, contribution to, and collaboration on multi-disciplinary content to support pre-visits before and class discussions after environmental activities. To this end, a collaborative online space is being designed that integrates features of geospatial web applications and 3D virtual online environments. Secondly, interactions with mobile devices are being designed to allow for student contribution, information retrieval and collaboration during field-trips where internet access is limited or not available at all. Thirdly, tangible media installations are being designed with the aim of engaging students in playful exploration of shared online information by combining physical Environmental Education activities with the virtual space in a mixed-reality environment.

Methodology. One of the main principles of Environmental Education is the inclusion of everyone when aiming at changed behaviour for an ecologically sustainable future [2]. In this respect, its strong participatory approach and vision for change has commonalities with principles of action research and participatory design which encourage users to play an active part in the design process [12]. This design research project uses qualitative methods of data collection, including participant observation, interviews, and focus groups in the form of future workshops. The project has used the case study of a 15-day environmental fieldtrip for an initial user needs analysis. The fieldtrip involved 26 high school students from 12 different schools in various activities around the theme 'waterways', including authentic tasks, such as water quality monitoring, ant investigations, and documentation of the event through visual and written artefacts as well as digital stories. The iterative prototyping and design evaluation will take place in similar environmental activities and will actively involve participants of these activities.

4 Discussion and outlook

We have introduced our work-in-progress by reviewing the context and potential ubiquitous computing use, the project's interaction design approaches and its methodology. We believe that further consideration of existing practices in Environmental Education is required to successfully use ubiquitous computing to facilitate the process of collecting and sharing outcomes of Environmental Education activities online. Such educational practice may, e.g., combine monitoring or other project activities, environmental experiences through physical activities and class discussions to effectively support student learning and engagement, as recommended by Ballantyne, Fien and Packer for Environmental Education [13].

Time has proven to be a contextual factor which is significant for both the educational and ubicomp aspects of our project. Environmental Education and online community development both acknowledge that long-term perspectives have to be taken into account for any initiative to be effective. Environmental Educators acknowledge that "changes in popular perspectives, values, knowledge and skills to achieve changed behaviour in support of a sustainable environment will not occur overnight" [2, p5]. Lazar and Preece support this notion in the ubicomp context, for "online communities are neither designed nor do they just emerge. How software is designed affects community development. The way people interact in a community contributes strongly to its long-term evolution. People's behavior cannot be controlled but it can be influenced" [14, p127].

Influencing people's behaviour is more a psychological and sociological and less a technical issue. We agree with Gilchrist who argues that "community development involves human horticulture rather than social engineering" [15, p269]. The motivation for this position paper stems from our strong belief that ubicomp technology offers new means to support the development of various communities and foster environmentally sustainable behaviour of their members. We would like to explore some of these ideas further in the collaborative environment of this Ubicomp 2007 workshop. So often, technology is designed with a "build it, and they will come" approach. However, we think a critical analysis of user needs, desires, effort, and especially motivation is key to better understand how ubicomp technology can realise opportunities for enhanced or augmented interaction in support of green values. Bina and Giaglis [16] propose a model to analyse factors stimulating extrinsic and intrinsic motivation – in their case, of members of a wireless community. Fuelling extrinsic motivation of users through material or in-kind incentives adds an increased level of complexity to the sustainability

equation. Encouraging intrinsic motivation, i.e. environmentally sustainable behaviour because users believe it is the right thing to do and it makes a difference, is a better option. Other disciplines may be able to shed light on approaches which are useful to adopt. Some of these might include the strategic use of elements of 'play' and 'competition' as found in many interactive games which keep users entertained for hours. Other approaches to stimulate intrinsic motivation may involve instant (but sometimes ambient) feedback mechanisms to allow users to monitor and control their impact on the environment.

We argue that appropriate solutions have to be sought to successfully and seamlessly embed engaging ubiquitous computing in existing practices. Ubiquitous computing should not be employed to replace environmental experiences, nor reduce their educational impact – which may indeed require actual hands-on activity. Instead, we think that ubicomp holds great potential for preparing and augmenting those experiences in Environmental Education and other fields that necessitate actual physical presence and activity.

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Natascha Matthes is a PhD candidate in the Creative Industries Faculty at Queensland University of Technology (QUT), Brisbane, Australia. She holds a Bachelor of Audiovisual Media from the University of Media in Stuttgart, Germany, and a Masters of Creative Industries in Communication Design from QUT.

Marcus Foth is a Senior Research Fellow with the Institute for Creative Industries and Innovation at QUT, and a 2007 Visiting Fellow at the Oxford Internet Institute, UK. Dr Foth is also the recipient of an Australian Postdoctoral Fellowship supported under the Australian Research Council's Discovery funding scheme (DP0663854). He received a PhD in digital media and urban sociology from QUT. He is a member of the Australian Computer Society and the Australian Interactive Media Industry Association.